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ABSTRACT

The Council of Chief State School Officers (CCSSO) established the State Education Assessment Center in 1985 to coordinate the development, analysis, and use of state-level data and charged the Center with implementing an education indicators model for reporting state-by-state data. This paper presents an analysis of state-by-state data on the characteristics of teachers in science and mathematics based on the work collected by state departments of education in the 1988-89 school year. The results of the indicators on science/math teachers are reported by: (1) district in terms of assignment category; (2) age, sex, and race; and (3) certification. (YP)

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State Science/Math Indicators Project

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USES OF STATE INDICATORS OF SCIENCE AND MATHEMATICS TEACHERS

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Based on data collected by State Departments of Education on public schools in Fall 1988.

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USES OF STATE INDICATORS OF SCIENCE AND MATHEMATICS TEACHERS

Many states have instituted reforms that are aimed at improving science and mathematics education in elementary and secondary schools. Standards for teacher certification have been raised, curricula have been revised, course requirements for graduation have been increased, and incentives have been provided for attracting and retaining teachers in science and mathematics. States also have been improving assessment programs and information systems to track the effects of state education reforms as well as to evaluate and report on the condition of education in our schools.

The Council of Chief State School Officers (CCSSO) established the State Education Assessment Center in 1985 to coordinate the development, analysis, and use of state-level data and charged the Center with implementing an education indicators model for reporting state-by-state data. Since 1986 CCSSO has received support from the National Science Foundation to develop and report on indicators of science and mathematics education. There are two major goals for the "State Science/Math Indicators Project": 1) to improve the quality and usefulness of data on science and mathematics education to assist state policymakers and program managers in making more informed decisions, and 2) to develop a system of indicators that provides the capacity for state-to-state comparisons of science and mathematics education as well as a national database to assess the condition of education in these subjects.

This paper presents an analysis of state-by-state data on the characteristics of teachers in science and mathematics based on the work of the State Science/Math Indicators Project. The data were collected by state departments of education in the 1988-89 school year and reported to CCSSO. The state-by-state data presented in this paper are cross-sectional data, but they are useful for considering issues in supply and demand of science and mathematics teachers.

The paper addresses three policy issues:

1. the current numbers and allocation of science and math teachers by state and teaching subject/field, and projected demand for teachers in the 1990's;

2. the problem of relatively low numbers of female and minority teachers in science and math; and

3. the proportion of science and teachers teaching "out-of-field," and the relationship to projected shortages.

NEED FOR IMPROVED STATISTICS ON TEACHER DEMAND AND SUPPLY

In 1984, Darling-Hammond reviewed data on science and math teachers and predicted severe shortages in the 1990's. Four reasons were cited: a) the number of teachers currently teaching "out-of-field," b) the low number of new entering science and math teachers, c) the high numbers of science and math teachers reaching retirement age, and, d) the high numbers of science and math teachers leaving teaching before retirement age. The National Science Teachers Association (NSTA) estimated in 1984 that 30 percent of all secondary science and mathematics teachers are "completely unqualified or severely underqualified" to teach these subjects (Johnston and Aldridge). NSTA also found that in the 1982-83 school year 12 teachers left teaching for each newly trained science/math teacher, and 40 percent of science and math teachers would retire by 1995 (Aldrich, 1983). Recently, researchers at the RAND Corporation projected that the total number of new science and math teachers that will need to be hired by 1995 is equal to the current teaching force in these subjects of about 300,000 teachers (Shavelson, et al, 1989, p.80).

Several questions can be raised about the projections of shortages of science and math teachers. First, the shortage projected by NSTA in 1983 (40 percent will retire by 1995) is not any greater than the average yearly demand for teachers by 1995. NCES projections for teacher

demand show that the equivalent of 10 percent of the total of about 1.1 million secondary teachers (110,000) will need to be hired in 1990. By 1995 the equivalent of 8 percent of the total secondary teachers will need to be hired each year. These projections take into account rates of turnover (retirement plus job change) and enrollment change. Thus, from 1990 to 1995 the equivalent of approximately 50% of the total secondary teacher force will need to be hired.

Second, there is not current evidence that turnover of science and math teachers is as high as predicted in 1983. Recent NCES projections show a small increase in teacher turnover rate--from current 6% to about 8% in 1995 (NCES, 1989a). In science, higher turnover rates are specific to chemistry and physics teachers, and are not general to math and all science fields. Weiss (1989) conducted a follow-up survey with the secondary science and math teachers surveyed in 1985-86 and found that about 85 percent were still in teaching in 1988, which is a turnover rate of 5 percent. National survey responses from principals on the difficulty of hiring teachers showed that over half the principals reported that physics and chemistry teachers were hard to hire (Weiss, 1987). Murnane, et al. (1988) analyzed the career patterns of science and math teachers in three states and found that attrition rates were higher among chemistry and physics teachers than among biology, mathematics, or history teachers. Chemistry and physics teachers had shorter periods of initial teaching years and were less likely to return to teaching than other teachers.

Third, the hiring of teachers in science and math is not dependent on the number of new graduates of teacher education programs. A committee of the National Research Council studying statistics on teacher supply and demand reported that evidence from recent hiring patterns of school districts shows that a majority of new hires are from the "reserve pool" of teachers who left teaching and decide to return as openings increase (National Research Council, 1987).

Finally, the evidence on the proportion of current teachers that are not qualified in their field of teaching is very mixed. National surveys of teachers show that a significant proportion of teachers are not qualified to teach subjects or courses to which they are assigned. However, the exact numbers vary with the measure of teacher "qualifications" that is used. The Carnegie Foundation for Advancement of Teaching found that an average of 20 percent of elementary and secondary teachers said they were "teaching subjects they were not qualified to teach," and states varied in percentage of non-qualified teachers from 12 percent (New Hampshire) to Utah (30 percent) (National Center for Education Statistics, 1989b). In a survey with a nationally-representative sample of science and mathematics teachers in 1985-86, teachers were asked to report on their degrees and course preparation. The results showed that only 7 percent of high school math teachers were teaching "out-of-field," and a lower percentage of science teachers were not trained in a science field. However, one-third of physics classes and one-fifth of chemistry classes were taught by a teacher not trained in those specific disciplines (Weiss, 1987).

DESIGN FOR STATE INDICATORS ON SCIENCE AND MATH TEACHERS

The review of existing data sources and the varying predictions concerning teacher shortages in specific teaching fields illustrate the need for improvements in capacity for making statistical projections at the national level. This need will largely be addressed with the results from the Schools and Staffing Survey being conducted on a periodic basis by NCES. However, while national statistics and projections give a general picture, teacher shortages vary widely by state, region, and district. Education decision-makers are likely to want data on the status of the teaching force that are more specific to their situation, and one approach is to provide state-level statistics. The National Research Council committee on teacher supply and demand statistics recommended development of improved state-level statistics for specific fields in science and

mathematics (1987).

The CCSSO Science/Math Indicators Project is beginning to address the need for better data on the teaching force at the state level. These data will help to identify current and projected teacher shortages in specific teaching fields, and highlight the demographic characteristics of the teaching force. These data might assist education policy-makers in determining strategies and programs for improving the teaching force, such as with incentives to attract people to teaching in science and mathematics. For example, Weiss' (1987) analysis of national data on teacher characteristics showed that minority and female science and math teachers are vastly under-represented considering the student population in our schools, and state-level data are needed on teachers in these groups.

During the 1988-89 school year, states reported data to CCSSO on several indicators of science and mathematics education, including high school course enrollments and teacher characteristics. The data were collected by state departments of education using regular state-designed systems for collecting information on teachers and student enrollments. The state-level data on teachers focused on two indicators: a) the number of teachers assigned to science and math by subject or field and by age, sex, and race/ethnicity, and, b) teacher assignments by certification status.

The state science/math indicators were selected and developed with states through a planning process. Three major steps were included in the process: a) development of a conceptual framework paper (Blank, 1986), which reviewed recommendations on needed indicators of science and mathematics education (e.g., National Science Board, 1983; Raizen and Jones, 1985; Shavelson, et al, 1987; Murnane and Raizen, 1988; Oakes, 1986) and outlined "ideal indicators" for science and math at the state level; b) a survey of state departments of education to determine the availability of data on science/math education and to identify state interests in

indicators (Blank and Espenshade, 1988b), and c) an advisory panel reviewed the available data and the ideal indicators and recommended a set of "priority indicators" upon which the CCSSO Project should focus its efforts. The indicators were selected in six categories (Student Outcomes, Instructional Time/Enrollment, etc.). For each recommended indicator, the best source of state-by-state data was identified, e.g., "NAEP" or "STATE DATA."

SCIENCE/MATH INDICATOR	DATA SOURCE
Student Outcomes	
STUDENT ACHIEVEMENT	NAEP
STUDENT ATTITUDES/INTENTIONS	NAEP
Instructional Time/Enrollment	
GRADES 7-12 COURSE ENROLLMENT	STATE DATA (CCSSO)
ELEMENTARY MINUTES PER WEEK	Schools/Staffing Survey (NCES)
Curriculum Content	
STUDENTS' "OPPORTUNITY-TO-LEARN"	NAEP
School Conditions	
CLASS SIZE by Subject/Course	Schools/Staffing Survey or State Data (Available in some states)
NO. of COURSE PREPARATIONS PER TEACHER	
COURSE OFFERINGS PER SCHOOL	
Teachers	
COURSES/CREDITS IN SCIENCE/MATH	Schools/Staffing Survey
TEACHING ASSIGNMENTS BY FIELD/SUBJECT By Age, Gender, Race/Ethnicity	STATE DATA (CCSSO)

TEACHING ASSIGNMENTS BY CERTIFICATION FIELD/SUBJECT (Number of Teachers Out-of-Field/Uncertified)	STATE DATA (CCSSO)
Equity	
GENDER AND RACE/ETHNICITY by Student or Teacher Indicator	STATE DATA (CCSSO) (where available)

The CCSSO Project advisory panel recommended that teacher characteristics be aggregated and reported by state departments of education, and that the data should be collected and reported for one point in time during a school year (e.g., October 1). The resulting state-by-state statistics would not provide projections of teacher demand and supply by state, but they could provide reliable, valid comparative data on science/math teachers by state without high costs to states. Additionally, with periodic reporting of teacher characteristics by state, trend analyses could be carried out.

State-level data on teacher assignments by state certification status is an important state-level indicator of teacher shortages. Knowing whether or not a teacher is certified for the courses he/she is teaching does not provide a good measure of teaching quality or of the individual's preparation in the field (Murnane and Raizen, 1988). However, the proportion of teachers who are teaching "out-of-field" is a useful policy indicator because it is a quantifiable measure of the proportion of teachers in a district or state that do not meet basic qualifications. This indicator has often been used to identify current teacher shortages in science, math, and other subjects (Shavelson, et al, 1989). A major advantage of state data on teacher assignments and certification is that the data can be computed from state administrative records and computerized data files, thereby alleviating the need for special surveys of teachers and use of data based on teacher self-reports. Since certification standards for each teaching field differ by state (Blank

and Espenshade, 1988a), it is important to report state-by-state statistics on teacher certification along with information on states' standards.

To obtain comparable state-by-state data, a Project task force comprised of state specialists in science, mathematics, and information systems designed a plan for state reporting of teacher characteristics. The plan specified that teacher data be reported according to percent of time teachers are assigned to mathematics, computer science, and six fields of science. Two categories of percent of time were specified: a) teachers who have their "primary assignment" in a subject/field (i.e., at least 50% of teaching time), and b) teachers who have a "secondary assignment" in a subject/field (less than 50% of teaching time in the field).

There are several reasons for reporting data on teachers by these two assignment categories. First, it is important to account for all teachers of science and mathematics, regardless of the number of courses or amount of time they spend teaching science or math. Second, to analyze the condition of the teaching force in science and math it is important to differentiate between teachers who are assigned to a specific subject or field, e.g., Biology or Physics, for the majority of the teaching day vs. teachers who may teach only one or two courses in a subject or field. For example, in order to offer a course in Physics, a school district may assign a teacher who is certified in Chemistry to teach the course because it is not possible to hire a full-time Physics teacher. That teacher may or may not also be certified to teach Physics. Thus, to analyze teacher certification data, the Project advisory panel recommended cross-tabulating certification by "primary assignment" vs. "secondary assignment," as well as cross-tabulating teacher age, sex, and race/ethnicity by the two assignment categories.

USES OF STATE-BY-STATE INDICATORS ON SCIENCE/MATH TEACHERS

In the first year of state reporting on science/math indicators, 39 states reported data on science/math teachers. In 1989-90 the same indicators were requested and CCSSO expects that all 50 states will report teacher data. The initial results can be used to address several policy issues concerning teacher supply and demand, and these results illustrate how these indicators of the teaching force can be used on a continuing basis.

Distribution of Science/Math Teachers

State-by-state data on the distribution of teachers to science and mathematics fields are shown in Tables 1 and 2. The "Total" at the bottom of each column shows the sum by assignment category and all teachers for each subject or field. With data from all 50 states, national totals would be available.

In Mathematics (Table 1), the state-by-state data show that two-thirds to three-fourths of math teachers in each state have their primary assignment (50% or more) in Mathematics. Exceptions to this pattern are in Arkansas (70 percent secondary assignment, or "part-time"), Illinois (47 percent), and Hawaii (46 percent). Smaller states, such as Montana, Nevada, South Dakota, and Utah, have more part-time Math teachers which comprise about one-third of all Math teachers in these states. In Computer Science, a majority of teachers are teaching Computer Science as a secondary assignment (less than 50% time).

The state-by-state data on science teachers in Table 2 show that in 23 of 39 states a majority of Biology teachers have their primary assignment (50% or more time) in Biology. For example, of 800 teachers in Alabama assigned to teach Biology, 491 teachers (61%) have their primary assignment in Biology. The proportion of Biology teachers with a primary assignment in the field varies from 89% in Pennsylvania to 26% in North Dakota. In Chemistry, 15 states

had a majority of teachers assigned 50% or more in Chemistry with the proportions varying from a high of 84 percent in Pennsylvania to a low of 21 percent in South Dakota. In Physics only 4 states had a majority of teachers assigned 50% or more in Physics (Connecticut, Idaho, North Carolina, Pennsylvania), and most teachers in the other 35 states teach Physics on a part-time basis.

States with more rural districts, such as Arkansas, Oklahoma, and North Dakota had fewer teachers with primary assignments in any of the science fields while states with a greater proportion of urban and suburban districts, such as Connecticut, New York, and Pennsylvania, had more teachers with primary assignments in one field. Southern states with whole-county districts, such as Mississippi, North Carolina, South Carolina, and Virginia, have higher proportions of math and science teachers with primary assignments in one field.

(The states also reported data on characteristics of teachers assigned in Earth Science, General Science, and Physical Science. These data are not analyzed in the paper but they are available from the author.)

A question that might be asked about the teaching force in science and mathematics in each state is how the number of teachers compares with the student population to be educated. A student:teacher ratio was computed for mathematics and three science fields, as shown in Table 3. A statistic of "estimated full-time equivalent teachers (FTE)" by subject/field was computed. Since the data were not requested from states in FTEs, estimated FTEs were computed from the state totals for primary and secondary assignments (.75 times the number with primary assignments (50% or more time) plus .25 times the number with secondary assignments (less than 50%)). The student:teacher ratio is the total grade 9-12 enrollment in the state divided by the estimated FTE for each subject/field.

The student:teacher ratios for mathematics vary from 62 students per teacher in Hawaii

to 242 in Mississippi. The low ratio in Hawaii may be due to inclusion of grades 7-8 in the total. In Biology, the ratio varies from 249 students per teacher in New York to 639 in California. In Physics the ratios vary from 868 in North Dakota to 7,654 in Mississippi. A large portion of high school students at each grade level are taking a Mathematics course and every high school has several Math teachers. Thus, the state student:teacher ratios reflect the average student load for a full-time math teacher. There are more Biology teachers than teachers in other science fields because almost all schools offer Biology. Since most students take only one Biology course, the ratios are higher than for Mathematics. The student:teacher ratios for Chemistry and Physics might be interpreted as an indicator of the capacity of schools in a state to offer courses in these fields. In Chemistry, almost all states have an average of a full-time equivalent teacher for the number of students that would comprise a large high school (i.e., 800 to 1800 students). Thus, on average, smaller high schools are likely to have only a part-time Chemistry teacher. In Physics, 12 of 29 states have a student:teacher ratio of over 2,000 students per full-time equivalent teacher and all but two states have a ratio over 1,000 students per teacher. These ratios indicate that on average only the largest high schools in a few states would have a full-time Physics teachers.

The student:teacher ratios for Chemistry and Physics provide an indication of the distribution of teachers to students, but possibly a school does not need a "full-time equivalent" teacher in physics. Decision-makers may be more interested in whether each school has someone to teach physics, if even one course. Table 4 displays the number of high schools in each state by the total "headcount" of teacher assigned to Physics (primary assignment or secondary assignment). These data reveal that 25 of 27 states (all except Alabama and New York) have more high schools than teachers assigned to Physics, and 12 states have less than two-thirds of high schools with a teacher assigned to Physics. In states such as California, Idaho, Mississippi,

Missouri, New Mexico, Oklahoma, South Dakota, and Utah only about half of the schools are able to offer a Physics course, unless several schools are cooperating in sharing a teacher (which is not reflected in these data). These data on number of schools that can offer Physics are consistent with findings of the 1985-86 national survey (Weiss, 1987) and a national survey of Physics teachers (Neuschatz and Covalt, 1989). State-level data provide more specific information that can be related to state or district policies, and can be useful in gauging the degree of severity of a problem such as shortages of Chemistry and Physics teachers.

Age, Sex, Race/Ethnicity of Science and Math Teachers

With state-by-state data on the demographic characteristics of teachers, it is possible for education decision-makers to see differences in the current teaching force in science and math which may be related to state policies and programs such as recruitment, certification, or early retirement, as well as to identify problems that need to be address such as the aging of the teaching force or under-representation of women and minority teachers. For the 1988-89 school year, 39 states reported data on the age, sex, and race/ethnicity of science/math assigned 50% or more to a math or science field. For purposes of comparison, states also reported the age, sex, and race/ethnicity of all high school teachers.

Age of Teachers. Table 5 lists the percentage of science and math teachers who are under age 30 and the percentage over age 50. These statistics can be used for estimating the future demand for teachers, i.e., number of younger teachers as compared to older teachers. The median state percentage of Math teachers under age 30 is 14% and the median percentage over age 50 is 16%, which indicates that in most states math teaching is not dominated by older teachers. State percentages vary considerably--from a high of 23% under 30 in Wyoming to a high of 28% over 50 in Minnesota. Eleven states reported more math teachers under 30 than over 50. The

state-reported data can be compared with national averages from survey data. For example, in the 1985-86 national survey of science and math teachers, 13 percent of math teachers in grades 10-12 were over 50 (Weiss, 1989).

In Biology, Chemistry, and Physics, there are higher percentages of older than younger teachers in most states, although the differences vary by field. Biology has an average of 11% under 30 and 17% over 50 (6 percent more teachers over 50 than under 30), Chemistry has an average of 12% under 30 and 22% over 50 (difference of 10 percent), and Physics has an average of 8% under 30 and 23% over 50 (difference of 15 percent). In states such as California, Delaware, Idaho, Minnesota, Mississippi, and Wisconsin the differences in ages of Chemistry and Physics teachers show that the demand will be higher for these teachers in the 1990's. From the higher percentage of younger teachers, states such as Kentucky, Nevada, Ohio, Pennsylvania, South Carolina, and Utah are less likely to have shortages in these fields. The national survey showed an average of 11 percent of science teachers in grades 7-9 over age 50 and 15 percent of science teachers in grades 10-12 (Weiss, 1989).

The state-by-state data on all high school teachers is not shown in a table. However, the median for all teachers is 11 percent under 30 and 17 percent age 50 and over. Eleven states had more teachers under 30 than over 50.

Sex of Science/Math Teachers. The 1985-86 national survey reported that 46 percent of math teachers in grades 10-12 and 51% in grade 7-9 were female, and that 31 percent of science teachers in grades 10-12 and 41 percent in grades 7-9 were female (Weiss, 1989). State-by-state the proportions of math and science teachers that are male and female vary widely, as shown in Table 6. For example, in mathematics the percent of female teachers varies from 20% in Minnesota to 76% in Texas, and the median is 43%. (The data on all high school teachers in these states shows 40% female in Minnesota and 67% female in Texas.) Ten states have more

female than male math teachers and all but New Jersey and Hawaii are states in the southeast. In Biology, the percentage of female teachers varies from 14% in Montana to 76% in Texas, and the median is 38%. Eight states have more female than male Biology teachers. Chemistry and Physics have lower average percentages of female teachers--30% median female in Chemistry and 18% median female in Physics. Eight states have more female than male Chemistry teachers, but only one state (Texas) has more female than male Physics teachers. The state median percentages for all high school teachers are 51% male and 49% female.

Race/Ethnicity. In 1985-86, the national figures for minority teachers' in science and math were: 10% minority math teachers in grades 7-9, 6% of grades 10-12 math teachers, 12% of grade 7-9 science teachers, and 8% of grades 10-12 science teachers (Weiss, 1989). The state-by-state data on race/ethnicity of science and math teachers are displayed in Tables 7-1 and 7-2. These percentages can be compared with the student race/ethnicity distributions (K-12) by state. (Student statistics were obtained from the NCES Common Core of Data for the 1988-89 school year.) Nationally, 30 percent of elementary and secondary students are minorities, and 70 percent are white.

Figure 1 shows a cross-tabulation of percentage minority teachers in three fields by the percentage minority students in the state. Among the 19 states that reported teacher race/ethnicity by field and student race/ethnicity, only eight states had over 10 percent minority Math teachers. Of the 13 states with more than 20% minority students, only 4 states had more than 15% minority math teachers (Alabama, Hawaii, Mississippi, and South Carolina). In Biology and Chemistry, the percentages of minority teachers are about the same as for Mathematics. Among the 13 states with over 20% minority students, five states had over 15% minority Biology teachers and five states had over 15% minority Chemistry teachers. Other than Hawaii, the four states with the highest proportions of minority teachers are all in the southeast: Alabama,

Mississippi, North Carolina, and South Carolina. The data show that except for Hawaii no state has representation of minority teachers which is similar to the racial/ethnic background of students. It would be very important to track these percentages over time to measure the extent of change.

Figure 1

PERCENTAGE MINORITY TEACHERS IN MATHEMATICS, BIOLOGY, AND CHEMISTRY BY PERCENTAGE MINORITY STUDENTS (K-12)

STATE	STUDENTS % MINORITY	% MINORITY TEACHERS Math	Biology	Chemistry
Utah	7%	2%	2%	1%
North Dakota	8	0	0	0
Kentucky	10	2	4	1
Wisconsin	14	1	1	2
Ohio	16	3	5	2
Pennsylvania	17	3	3	1
Nevada	23	9	8	3
Colorado	24	4	NA	NA
Connecticut	24	3	4	3
Arkansas	25	11	10	7
Oklahoma	25	5	4	2
Delaware	31	9	7	4
New Jersey	33	10	7	4
North Carolina	33	14	17	11
Alabama	37	19	19	15
South Carolina	42	23	25	16
Texas	49	15	NA	17
Mississippi	51	27	31	31
Hawaii	77	72	72	63

Source: Data on Public Schools, State Departments of Education, October 1988.

Certification of Science/Math Teachers

An important component of an analysis of teacher shortages and the demand for teachers is the proportion who are teaching "out-of-field," i.e., not trained in the field in which they are assigned to teach. For states, a relevant measure of out-of-field teaching, and teacher shortages, is the proportion of teachers who not state certified in a subject or field in which they area teaching.

States reported teacher assignments in science and math by certification status. The data are displayed in Tables 8-1 through 8-4. Teachers were defined as "out of field" if they were certified in a field/subject other than the one assigned or if they had a temporary, provisional, or emergency certification. As outlined in the Project design, the certification statistics are reported by teachers primary assignment (50% or more time) and secondary assignment (less than 50% time). For state-by-state comparisons, information is reported in Table 8-5 on the number of credits required for state certification in each field.

Mathematics. Table 8-1 shows that the proportion of math teachers assigned out-of-field is widely varied--from three states (Connecticut, North Dakota, and Wyoming) having 0 percent out-of-field to Colorado having 32 percent out-of-field. The medians of 3 percent out-of-field for primary assignments and 3 percent for secondary assignments tend to mask the high numbers in a few states. In two states (Montana and Oregon) the large majority of teachers out-of-field are those with a secondary assignment as math teachers, but in other states the percentages are fairly even for both assignment categories.

One possible explanation for variation among the states in the proportion of teachers out-of-field is the differences in certification requirements. If a state has more stringent requirements, it might be expected that more teachers would be teaching out of field because it is harder to

hire new teachers who are certified or to assign current teachers who also have a Math certification. States with lower requirements would be predicted to have fewer teachers out-of-field.

To test the hypothesis, the total percentage of teachers out-of-field in each state was cross-tabulated by the number of math credits required for certification, as shown in Figure 2. The pattern of results show some support for the hypothesis--three states with the highest percentage of math teachers out-of-field have high credit requirements (Montana, Kentucky, and California) and two states with the lowest requirements (Idaho and North Dakota) have few teachers out-of-field in Math. However, there are contradictions to the hypothesis--Nevada and South Dakota have low requirements but high proportions of teachers out-of-field (16%, 29%), and Missouri and Ohio have high requirements but only 1% of teachers out of field. An alternate explanation for the pattern in these states may be the extent of change in school age population. Nevada's teacher shortage might be attributed to its 16 percent school-age population increase from 1977-87 (as compared to the U.S. total of 9 percent decrease). Decline in school-age population could explain the lack of shortage of teachers in Missouri (13% decrease) and Ohio (17 % decrease). South Dakota had a 13 percent decrease in school-age population, but still has a teacher shortage in Mathematics. A factor may be the number of small, rural districts (81% of districts under 1000 students vs. 61% for the U.S.). However, there may be a number of factors that affect teachers in individual states such as low pay or early retirement options.

Figure 2

PERCENTAGE OF MATHEMATICS TEACHERS OUT-OF-FIELD
BY CREDITS REQUIRED FOR STATE CERTIFICATION

Math Credits Required	0 - 10 % Out-Of-Field	11 - 32 % Out-Of-Field
20 Credits or Less	Idaho (6%) North Dakota (0)	Nevada (16%) South Dakota (29%)
21 - 29 Credits	Alabama (6%) Mississippi (9) Virginia (3) Wyoming (0) New York (8)	Oregon (12%)
30 - 45 Credits	Missouri (1%) Ohio (1) Oklahoma (8)	Montana (20%) Kentucky (13) California (31)
Credits set by degree-granting institution	Minnesota (3%) North Carolina (5) Utah (5) Pennsylvania (8) South Carolina (9)	Colorado (32%)

Source: Data on Public Schools, State Departments of Education, October 1988.
Blank and Espenshade (1988a)

Biology. An analysis of assignment by certification in science teaching fields requires the additional variable of type of science certification. Forty states have a "broad-field" science certification which typically provides certification for teaching in any secondary science field. Although the certification requirements for broad-field certification vary among states (see Table 9), in most states the reason for this type of certification is to provide districts and schools with greater flexibility in hiring and assigning science teachers. Some offer teachers the option of "specific-field" or broad-field certification, but 10 states offer science certifications for only specific fields--Biology, Chemistry, Physics, Earth Science, etc. One hypothesis concerning science certifications would be that states with broad-field certification have fewer teachers out-of-field than states with only specific-field certification.

The state data in Table 8-2 show that on average a smaller proportion of Biology teachers are assigned out-of-field than are Math teachers. However, as with Math teachers, the low average percentages out-of-field (medians: 1% and 2%) obscure the substantial proportion of teachers out-of-field in states such as California, Mississippi, Montana, New York, and South Dakota. A large proportion of Biology teachers are certified with broad-field certification (medians of 12% and 11%), and particularly in California, Nevada, North Carolina, Ohio, and South Carolina.

A cross-tabulation of percentage of Biology teachers out-of-field by state certification requirements, in Figure 3, provides an analysis of differences in level of requirements and broad-field vs. specific field certification. The results show that states with a broad-field certification do not have lower rates of out-of-field teaching. The three states with the highest percentages out-of-field--South Dakota, California, and Montana--all have broad-field certification. However, there is some evidence that a higher credit requirement for either specific-field or broad-field certification is related to a higher proportion of teachers assigned out-of-field. Of the three states

Figure 3

PERCENTAGE OF BIOLOGY TEACHERS OUT-OF-FIELD
BY STATE CERTIFICATION REQUIREMENTS

Biology Credits Required	0 - 10 % Out-Of-Field	11 - 39 % Out-Of-Field
Specific-Field Certification		
12 to 24 Credits	Connecticut (0%) Virginia (3)	
25 to 45 Credits	New York (8%) Oklahoma (5)	Mississippi (11%)
Broad-Field Certification		
18 To 36 Credits	North Dakota (0%) Wyoming (0) Missouri (3) Nevada (6)	South Dakota (25%)
37 to 60 Credits	Alabama (3%) Idaho (2) Kentucky (2) Ohio (1) Oklahoma (7)	California (28%) Montana (39)
Credits set by degree-granting institution	Minnesota (3%) North Carolina (2) South Carolina (5) Utah (7) Pennsylvania (3)	

Source: Data on Public Schools, State Departments of Education, October 1988.
Blank and Espenshade (1988a)

with 0 percent out-of-field, Connecticut requires only 18 credits (specific-field), North Dakota requires 21 credits for broad-field certification and 12 credits for specific-field certification, and Wyoming requires 30 credits for broad-field and 12 credits for specific-field certification.

It is likely that state demographic variables contribute to the high rates of teachers out-of-field in several states. California (28%) experienced a 3 percent increase in school-age population over 10 years and the state requires 45 credits for a "Life Science" certification. South Dakota (25%) and Montana (39%) have a high proportion of small, rural districts, and these kinds of districts have greater difficulty in hiring certified science and math teachers.

Physics. State data on assignment by certification status for Chemistry are in Table 8-3 and data for Physics are in Table 8-4. This analysis will be limited to Physics, although some of the patterns are similar for Chemistry. Of the total Physics teaching force, an average of 72% are teaching Physics as a secondary assignment. The median percentages of Physics teachers out-of-field (2% primary assignment and 12% secondary assignment) show that certified Physics teachers are much harder to hire than teachers of Biology.

The cross-tabulation of percent out-of-field with state requirements shows that neither broad-field vs. specific-field or the number of credits is related to percent of Physics teachers out-of-field. All but six states with state requirements have more than 16 percent of Physics teachers out-of-field, with the highest percentages in Mississippi (61%), South Dakota (53%), and Montana (76%). States with many small districts (South Dakota, Montana), mostly rural districts (Alabama, Mississippi, Kentucky) as well as states with more urban districts (California, New York) have shortages of Physics teachers. It should be noted that some states

Figure 4

PERCENTAGE OF PHYSICS TEACHERS OUT-OF-FIELD
BY STATE CERTIFICATION REQUIREMENTS

Physics Credits Required	0 - 10 % Out-Of-Field	11 - 76% Out-Of-Field
Specific-Field Certification		
12 to 24 Credits	Connecticut (0%)	Virginia (16%)
25 to 45 Credits		New York (20%) Oklahoma (26) Mississippi (61%)
Broad-Field Certification		
18 to 36 Credits	North Dakota (0%) Wyoming (0) Nevada (2)	Missouri (16%) South Dakota (53)
37 to 60 Credits	Ohio (2%) Idaho (2)	Kentucky (18%) Alabama (27) California (23) Montana (76)
Credits set by degree-granting institution	Utah (2%) North Carolina (5) South Carolina (11) Pennsylvania (7)	Minnesota (13%)

Source: Data on Public Schools, State Departments of Education, October 1988.
Blank and Espenshade (1988a)

with low percentages of Physics teachers out-of-field were states identified in Table 3 as having low numbers of teachers relative to the number of high schools in the states, including Idaho, North Dakota, Utah, Ohio, Nevada, Wyoming. In these states, districts and schools assign few teachers out-of-field, but the state also offers only limited opportunities for Physics since many schools have no Physics teacher either certified or non-certified.

If we know the proportion of Physics teachers (or teachers in other fields) that are certified vs. assigned out-of-field in a state, is this a useful indicator of the qualifications or preparation of Physics teachers (or teachers in other fields)? Using the example of Physics, other data on teacher qualifications can be considered. From a national survey of Physics teachers, Neuschatz and Covalt (1988) found that 26 percent of Physics teachers have a college degree in Physics. Of the current Physics teachers, about one-third started their teaching career in Physics, about one-third started in another science teaching field but have 10 years experience in Physics teaching, and about one-third are assigned for the first time or have occasionally taught Physics. Only about 1 percent of current Physics teachers were trained in a field other than science or math. Data from the 1985-86 survey of science and math teachers, show that 65 percent of Physics classes were taught by a teacher with 6 or more courses in Physics, whereas 88 percent of Biology classes were taught by a teacher with 6 or more courses in Biology (Weiss, 1987). Weiss (1987) also found that all but 6% of teachers assigned to teach a science course have a degree in a science (Weiss, 1987).

These national-level studies show that a large proportion of Physics teachers do not have extensive preparation in Physics, although almost all have preparation in a field of science or math. Thus, the state data on certification status could be viewed as an estimate of the proportion of Physics teachers that do not meet basic standards for the field, but the data do not measure the extent or quality of preparation. The advantages of certification data for state-level

analyses is that the data can be produced from existing data files, they can be related to state policies, and they can be used for state-by-state comparisons.

CONCLUSIONS

The analysis of state-level data on science and mathematics teachers in this paper shows that national statistics on teacher supply and demand are sometimes insufficient for analyzing specific policy issues. The analysis of age of science and math teachers by state showed that projections of high teacher attrition due to retirements over the next 10 years will present a severe problem in some states if actions are not taken. However, national survey data do not show a severe problem of attrition except in selected fields of science. Similarly, large state differences in the proportions of female and male math and science teachers are averaged out in national totals, and the national average can mask the degree to which students in difference states have opportunities to learn from female (or male) science and math teachers. State-by-state data on teacher race/ethnicity accentuate the disparity between teacher and student populations indicated by national averages.

The state-by-state analysis of the distribution of science and math teachers revealed some very specific information about teacher shortages. Current shortages in math and science were identified for some states by the proportion of teachers assigned out-of-field, while in other states shortages are identified by analyzing the number of teachers per school and student:teacher ratios. The state data show that differences in state requirements for certification have some relationship to the proportion of teachers assigned out-of-field. However, other state characteristics are also related such as the number of small districts and rural location, as well as the rate of change in school-age population. It is also apparent from the data on teachers per school that decisions about offering courses in science fields have an effect on the proportion of teachers in a state

assigned out-of-field. Some states have few teachers out-of-field but also offer relatively few student opportunities to take courses such as Physics.

As education decision-makers ask for improved data and statistics to track progress in our educational system, it is important to ensure that key policy questions can be addressed by the statistics. The initial results from state-by-state reporting on teachers in science and mathematics show that state-level data and statistics can be very informative about policy issues. This is particularly the case with data on teachers since states have a large role in defining the conditions by which teachers are trained, certified, hired, and assigned, as well as the school conditions for teaching and how teachers are paid. This paper illustrates how state-level data on key teacher characteristics can be used to inform education decision-makers and to identify potential problems with teacher shortages that could be further analyzed with more complex models.

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Table 1
MATHEMATICS AND COMPUTER SCIENCE TEACHERS (GRADES 9-12) BY PERCENT OF TEACHING ASSIGNMENT

STATE	MATHEMATICS			COMPUTER SCIENCE		
	50% or More	Less Than 50%	Total	50% or More	Less Than 50%	Total
Alabama	1,226	383	1,609	40	73	113
Alaska	--	--	--	--	--	--
Arizona	--	--	--	--	--	--
Arkansas	729	1,723	2,452	--	--	--
California	6,440	3,163	9,603	92	504	596
Colorado	1,251	134	1,385	--	--	--
Connecticut	1,535	89	1,624	63	196	259
Delaware	316	*	316	9	--	9
Dist. of Columbia	--	--	--	--	--	--
Florida	--	--	--	--	--	--
Georgia	--	--	--	--	--	--
Hawaii**	736	619	1,355	4	29	33
Idaho	526	81	607	--	--	--
Illinois	3,516	3,296	6,812	304	457	761
Indiana	--	--	2,321	--	--	212
Iowa	*	*	1,820	*	*	448
Kansas**	*	*	1,799	*	*	344
Kentucky	1,382	309	1,691	24	137	161
Louisiana	*	*	3,466	*	*	626
Maine	--	--	--	--	--	--
Maryland	*	*	2,298	*	*	*
Massachusetts**	*	*	3,658	*	*	*
Michigan	--	--	--	--	--	--
Minnesota	1,333	527	1,860	54	189	243
Mississippi	694	69	762	54	28	82
Missouri	1,738	300	2,038	232	284	516
Montana	346	182	528	52	185	237
Nebraska	--	--	--	--	--	--
Nevada	480	162	642	51	67	118
New Hampshire	--	--	--	--	--	--
New Jersey	4,596	*	4,596	259	443	702
New Mexico	538	58	596	*	*	*
New York	6,197	2,014	8,211	228	928	1,156
North Carolina	2,656	310	2,966	136	146	282
North Dakota	287	185	472	38	259	297
Ohio	3,802	395	4,197	304	345	649
Oklahoma	1,487	196	1,683	91	209	300
Oregon	1,062	263	1,325	*	*	*
Pennsylvania**	5,393	156	5,549	*	*	*
Rhode Island	444	*	444	42	*	42
South Carolina	1,687	208	1,895	54	76	130
South Dakota	305	153	458	75	160	235
Tennessee	--	--	--	--	--	--
Texas	7,398	2,336	9,734	655	821	1,476
Utah	667	269	946	63	59	122
Vermont	--	--	--	--	--	--
Virginia	2,602	531	3,133	87	164	251
Washington	--	--	--	--	--	--
West Virginia	--	--	--	--	--	--
Wisconsin	2,834	403	3,237	135	455	590
Wyoming	263	100	363	*	*	*
Total	64,466	18,614	98,451	3,146	6,214	10,990

*State does not collect or cannot report data for category

**Kansas, Hawaii and Pennsylvania: grades 7-12; Massachusetts: grades K-12 includes 96 math/science teachers

-- State did not report data on teacher assignments for 1988-89

Source: State Departments of Education, Data on Public Schools, Fall 1988

Table 2
BIOLOGY, CHEMISTRY, AND PHYSICS TEACHERS (GRADES 9-12) BY PERCENT OF TEACHING ASSIGNMENT

STATE	BIOLOGY			CHEMISTRY			PHYSICS		
	50% or More	Less Than 50%	Total	50% or More	Less Than 50%	Total	50% or More	Less Than 50%	Total
Alabama	491	309	800	125	235	360	51	273	324
Alaska	--	--	--	--	--	--	--	--	--
Arizona	--	--	--	--	--	--	--	--	--
Arkansas	287	312	599	75	194	269	6	219	225
California	2,152	1,476	3,628	685	629	1,314	226	619	845
Colorado+	•	•	•	•	•	•	•	•	•
Connecticut	485	81	566	234	59	293	128	53	181
Delaware	60	•	60	24	•	24	39	•	39
Dist. of Columbia	--	--	--	--	--	--	--	--	--
Florida	--	--	--	--	--	--	--	--	--
Georgia	--	--	--	--	--	--	--	--	--
Hawaii**	80	80	160	35	16	51	13	24	37
Idaho	184	16	200	53	1	54	23	4	27
Illinois	1,244	296	1,540	639	307	946	270	349	619
Indiana	•	•	1,001	•	•	501	•	•	370
Iowa	•	•	414	•	•	118	•	•	98
Kansas**	•	•	742	•	•	404	•	•	290
Kentucky	276	433	709	151	196	347	15	195	210
Louisiana	•	•	827	•	•	430	•	•	244
Maine	--	--	--	--	--	--	--	--	--
Maryland+	•	•	•	•	•	•	•	•	•
Massachusetts**	•	•	758	•	•	458	•	•	254
Michigan	--	--	--	--	--	--	--	--	--
Minnesota	453	299	752	195	292	487	96	282	378
Mississippi	336	82	419	93	51	144	11	35	46
Missouri	668	335	1,003	226	340	566	59	315	374
Montana	87	125	212	30	107	137	17	100	117
Nebraska	--	--	--	--	--	--	--	--	--
Nevada	102	91	193	34	27	61	15	30	45
New Hampshire	--	--	--	--	--	--	--	--	--
New Jersey	853	--	853	137	--	137	137	--	137
New Mexico	194	107	301	52	70	122	13	59	72
New York	3,349	1,875	5,224	1,262	663	1,925	504	685	1,189
North Carolina	1,036	145	1,181	469	84	553	264	67	331
North Dakota	66	192	258	21	126	147	6	137	143
Ohio	1,228	457	1,685	632	353	985	203	539	742
Oklahoma	576	336	912	135	334	469	25	197	222
Oregon	263	53	316	•	•	•	•	•	•
Pennsylvania**	1,552	185	1,737	829	153	982	457	184	641
Rhode Island	160	•	160	75	•	75	41	•	41
South Carolina	462	180	632	198	124	322	41	173	214
South Dakota	87	145	232	31	117	148	9	121	130
Tennessee	--	--	--	--	--	--	--	--	--
Texas	2,242	1,616	3,858	753	802	1,555	180	743	923
Utah	311	127	438	69	33	102	21	42	63
Vermont	--	--	--	--	--	--	--	--	--
Virginia	779	222	1,001	395	148	543	156	176	332
Washington	--	--	--	--	--	--	--	--	--
West Virginia	--	--	--	--	--	--	--	--	--
Wisconsin	848	248	1,096	309	244	553	118	280	398
Wyoming	72	70	142	29	70	99	8	70	78
Total	20,973	9,893	34,609	7,996	5,775	15,681	3,152	5,971	10,379

*State does not collect or cannot report data for category

**Kansas, Hawaii and Pennsylvania: grades 7-12; Massachusetts: grades K-12 includes 96 math/science teachers

-- State did not report data on teacher assignment for 1988-89

+ Colorado: 1,218 science teachers (all fields); 1,060 50% or more, 158 less than 50%; Maryland: 2,060 science teachers (all fields)

Source: State Departments of Education, Data on Public Schools, Fall 1988

Table 3
RATIO OF STUDENTS IN GRADES 9-12 TO MATHEMATICS AND SCIENCE TEACHERS

	MATHEMATICS		BIOLOGY		CHEMISTRY		PHYSICS	
STATE	Estimated FTE Teachers	Students Per Teacher	Estimated FTE Teachers	Students Per Teacher	Estimated FTE Teachers	Students Per Teacher	Estimated FTE Teachers	Students Per Teacher
Alabama	1,015	200	446	456	153	1,332	107	1,907
Arkansas	978	102	293	340	105	952	59	1,682
California	5,621	225	1,983	639	671	1,888	324	3,908
Colorado	972	162	--	--	--	--	--	--
Connecticut	1,174	113	384	344	190	694	109	1,209
Hawaii*	707	62	80	548	30	1,450	16	2,785
Idaho	415	141	142	411	40	1,459	18	3,198
Illinois	3,461	145	1,007	497	556	901	290	1,728
Kentucky	1,114	163	315	577	162	1,121	60	3,031
Minnesota	1,132	191	415	520	219	984	143	1,513
Mississippi	538	242	273	478	83	1,577	17	7,654
Missouri	1,379	172	585	405	255	931	123	1,926
Montana	305	138	97	436	49	855	38	1,115
Nevada	401	122	99	494	32	1,520	19	2,615
New Mexico	418	183	172	445	57	1,357	25	3,130
New York	5,151	144	2,981	249	1,112	668	549	1,353
North Carolina	2,070	156	813	396	373	864	215	1,500
North Dakota	262	129	98	345	47	712	39	868
Ohio	2,950	166	1,035	530	562	977	287	1,913
Oklahoma	1,164	141	516	319	185	891	68	2,421
Oregon	862	154	211	630	--	--	--	--
Pennsylvania*	4,084	123	1,210	414	660	758	389	1,288
South Carolina	1,317	135	384	463	180	991	74	2,405
South Dakota	267	127	102	335	53	648	37	919
Texas	6,133	145	2,086	428	765	1,165	321	2,780
Utah	568	192	265	411	80	1,815	26	4,148
Virginia	2,084	136	640	443	333	850	161	1,759
Wisconsin	2,226	108	698	338	293	807	159	1,490
Wyoming	222	123	72	382	39	695	24	1,161

*Hawaii and Pennsylvania: grades 7-12

Notes: Estimated FTE (Full-time equivalent) Teachers = 0.75 times the number with primary assignment (50% or more time) in subject/field plus 0.25 times number with secondary assignment (less than 50% time) in subject/field.

Students Per Teacher = Total Students 9-12 divided by Estimated FTE Teachers.

Souce: State Departments of Education, Data on Public Schools, Fall 1988

Table 4
NUMBER OF HIGH SCHOOLS BY TOTAL MATHEMATICS AND SCIENCE TEACHERS (GRADES 9-12)

STATE	HIGH SCHOOLS	TOTAL TEACHERS			
		Mathematics	Biology	Chemistry	Physics
Alabama	280	1,609	800	360	324
Arkansas	432	2,452	599	269	225
California	1797	9,603	3,628	1,314	845
Colorado	371	1,385	*	*	*
Connecticut	227	1,624	566	293	181
Hawaii**	53	1,355	160	51	37
Idaho	174	607	200	54	27
Illinois	980	6,812	1,540	946	619
Indiana	447	2,321	1,001	501	370
Iowa	531	1,820	414	118	98
Kansas**	458	1,799	742	404	290
Kentucky	337	1,691	709	347	210
Louisiana	378	3,466	827	430	244
Massachusetts	379	3,658	758	458	254
Minnesota	526	1,860	752	487	378
Mississippi	224	762	419	144	46
Missouri	603	2,038	1,003	566	374
Montana	213	528	212	137	117
Nevada	74	642	193	61	45
New Mexico	173	596	301	122	72
New York	1000	8,211	5,224	1,925	1,189
North Carolina	468	2,966	1,181	553	331
North Dakota	247	472	258	147	143
Ohio	986	4,197	1,685	965	742
Oklahoma	633	1,683	912	469	222
Oregon	306	1,325	316	*	*
Pennsylvania**	787	5,549	1,737	982	641
Rhode Island	59	444	160	75	41
South Carolina	282	1,895	632	322	214
South Dakota	284	458	232	148	130
Texas	1390	9,734	3,858	1,555	923
Utah	211	946	438	102	63
Virginia	379	3,133	1,001	543	332
Wisconsin	563	3,237	1,096	553	398
Wyoming	103	363	142	99	78

*State does not collect or cannot report data for category

**Hawaii, Kansas, and Pennsylvania: grades 7-12; Massachusetts: grades K-12 includes 96 math/science teachers

Note: Total Teachers = Teachers with primary or secondary assignment in subject/field, i.e. "headcount" of teachers.

Source: State Departments of Education, Data on Public Schools, Fall 1988; National Center for Education Statistics, Fall 1988

Table 5

TEACHERS UNDER AGE 30 AND OVER 50 ASSIGNED 50% OR MORE IN MATHEMATICS, BIOLOGY, CHEMISTRY, PHYSICS (GRADES 9-12

	MATH			BIOLOGY			CHEMISTRY			PHYSICS		
STATE	50% or More	Under 30	Over 50	50% or More	Under 30	Over 50	50% or More	Under 30	Over 50	50% or More	Under 30	Over 50
Alabama	1,226	10%	14%	491	8%	12%	125	8%	11%	51	18%	20%
Arkansas	729	14%	15%	287	10%	14%	75	8%	17%	6	0%	33%
California	6,440	14%	41%	2,152	10%	22%	685	12%	26%	226	9%	29%
Colorado	1,251	9%	21%	*	*	*	*	*	*	*	*	*
Connecticut	1,535	5%	21%	485	6%	23%	234	8%	29%	128	3%	35%
Delaware	316	7%	19%	60	5%	18%	24	4%	21%	39	8%	21%
Hawaii**	736	6%	12%	80	13%	16%	35	9%	23%	13	8%	15%
Idaho	526	16%	17%	184	8%	18%	53	6%	25%	23	17%	30%
Illinois	3,516	12%	21%	*	*	*	*	*	*	*	*	*
Kentucky	1,382	21%	9%	276	11%	16%	151	13%	12%	15	13%	13%
Minnesota	1,333	8%	28%	453	8%	28%	195	9%	36%	96	7%	33%
Mississippi	694	16%	17%	337	12%	17%	93	13%	22%	11	0%	36%
Missouri	1,738	15%	15%	668	14%	14%	226	12%	19%	59	5%	19%
Montana	346	13%	12%	87	6%	23%	52	6%	17%	17	0%	24%
Nevada	480	11%	19%	102	11%	22%	34	21%	9%	15	13%	13%
New Jersey	4,596	9%	20%	853	9%	23%	137	14%	24%	137	14%	23%
New York	6,197	9%	16%	3,349	11%	17%	1,262	10%	22%	504	7%	21%
North Carolina	2,656	20%	10%	1,036	21%	13%	469	46%	29%	264	15%	17%
North Dakota	287	21%	13%	66	11%	17%	21	0%	24%	6	0%	17%
Ohio	3,802	17%	11%	1,228	12%	13%	632	13%	16%	203	10%	15%
Oklahoma	1,487	20%	14%	576	16%	14%	91	26%	24%	25	12%	24%
Oregon	1,062	14%	17%	263	8%	13%	*	*	*	*	*	*
Pennsylvania**	5,393	6%	0%	1,552	6%	1%	829	6%	1%	457	6%	0%
South Carolina	1,687	17%	11%	452	15%	10%	198	15%	15%	41	7%	17%
South Dakota	305	20%	15%	87	14%	24%	31	13%	16%	9	0%	22%
Utah	677	16%	21%	311	12%	22%	69	13%	16%	21	10%	19%
Virginia	2,602	12%	16%	779	12%	16%	396	13%	18%	156	13%	31%
Wisconsin	2,834	12%	25%	848	6%	27%	309	8%	28%	118	7%	37%
Wyoming	263	23%	12%	72	15%	18%	29	7%	31%	8	0%	100%
Total	56,096	6,972	9,997	17,134	1,863	2,802	6,454	1,081	1,210	2,648	236	528
Median		14%	16%		11%	17%		12%	19%		8%	23%

*State does not collect or cannot report data for category

**Grades 7-12

Source: State Departments of Education, Data on Public Schools, Fall 1988

Table 6

GENDER OF TEACHERS ASSIGNED 50% OR MORE IN MATHEMATICS, BIOLOGY, CHEMISTRY, PHYSICS (Grades 9-12)

	MATH			BIOLOGY			CHEMISTRY			PHYSICS		
STATE	50% or More	Male	Female	50% or More	Male	Female	50% or More	Male	Female	50% or More	Male	Female
Alabama	1,226	34%	66%	491	36%	64%	125	38%	62%	51	55%	45%
Arkansas	729	39%	61%	287	49%	51%	75	59%	41%	6	100%	0%
California	6,440	52%	48%	2,152	70%	30%	685	70%	30%	226	87%	13%
Colorado	1,251	62%	38%	*	*	*	*	*	*	*	*	*
Connecticut	1,535	55%	45%	485	65%	35%	234	69%	31%	128	89%	11%
Delaware	316	51%	49%	80	62%	38%	24	71%	29%	39	67%	33%
Hawaii**	736	35%	59%	80	49%	51%	35	40%	57%	13	69%	31%
Idaho	526	72%	28%	184	80%	20%	53	94%	6%	23	91%	9%
Illinois	3,516	59%	41%	*	*	*	*	*	*	*	*	*
Kentucky	1,382	41%	59%	276	56%	44%	151	53%	47%	15	80%	20%
Minnesota	1,333	80%	20%	453	82%	18%	195	84%	16%	96	89%	11%
Mississippi	694	35%	65%	337	39%	61%	93	45%	55%	11	73%	27%
Missouri	1,738	49%	51%	668	61%	39%	226	65%	35%	59	78%	22%
Montana	346	68%	23%	87	82%	14%	52	48%	10%	17	76%	18%
Nevada	480	60%	40%	102	72%	28%	34	79%	21%	15	87%	13%
New Jersey	4,596	41%	59%	853	56%	44%	137	65%	35%	137	65%	35%
New York	6,197	57%	43%	3,349	62%	38%	1,262	72%	28%	504	86%	14%
North Carolina	2,656	31%	69%	1,036	43%	57%	469	46%	54%	264	61%	39%
North Dakota	287	67%	33%	66	86%	14%	21	86%	14%	6	100%	0%
Ohio	3,802	59%	41%	1,228	71%	29%	632	71%	28%	203	82%	18%
Oklahoma	1,487	50%	50%	576	62%	38%	91	98%	51%	25	96%	4%
Oregon	1,062	73%	27%	283	78%	22%	*	*	*			
Pennsylvania**	5,393	61%	39%	1,552	72%	28%	829	72%	28%	457	88%	12%
Rhode Island	*	*	*	160	62%	38%	*	*	*	*	*	*
South Carolina	1,687	31%	69%	452	38%	62%	198	43%	57%	41	59%	41%
South Dakota	305	71%	29%	87	83%	17%	31	74%	26%	9	89%	11%
Texas	7,398	24%	76%	2,242	24%	76%	753	21%	79%	180	21%	79%
Utah	677	70%	30%	311	78%	22%	69	83%	17%	21	90%	10%
Virginia	2,602	34%	66%	779	42%	58%	396	44%	56%	156	70%	30%
Wisconsin	2,834	66%	34%	848	85%	15%	309	84%	16%	118	87%	13%
Wyoming	263	63%	37%	72	81%	19%	29	90%	10%	8	75%	25%
Total	63,495	31,176	32,273	19,537	11,419	8,113	7,208	4,455	2,768	2,829	2,167	659
Median		57%	43%		62%	38%		70%	30%		82%	18%

*State does not collect or cannot report data for category

**Grades 7-12

Source: State Departments of Education, Data on Public Schools, Fall 1988

Table 7-1

RACE/ETHNICITY OF TEACHERS ASSIGNED 50% OR MORE IN MATHEMATICS AND BIOLOGY (GRADES 9-12)

	MATHEMATICS TEACHERS						BIOLOGY TEACHERS					
STATE	Total 50% or More	Hispanic	White	Black	Asian	Indian	Total 50% or More	Hispanic	White	Black	Asian	Indian
Alabama	1,226	0	80.9%	18.8%	0	0	491	0	80.9%	18.7%	0	.2%
Arkansas	729	0	89.0%	10.7%	.3%	0	287	0	89.9%	9.4%	.3%	.3%
California	6,440	5.1%	83.2%	4.5%	5.7%	.71%	2,152	5.2%	84.1%	4.4%	4.7%	.7%
Colorado	1,251	2.4%	95.6%	1.0%	.5%	.56%	*	*	*	*	*	*
Connecticut	1,535	.8%	97.1%	1.8%	.3%	0	485	.4%	95.9%	3.3%	.7%	0
Delaware	316	0	90.8%	8.9%	0	0	60	0	93.3%	6.7%	0	0
Hawaii**	736	0	12.9%	.7%	48.8%	0	80	0	27.5%	1.3%	71.3%	0
Idaho	526	0	98.5%	0	1.1%	.38%	184	0	98.9%	.0%	0	1.1%
Kentucky	1,382	0	97.9%	2.0%	.1%	0	276	.4%	95.7%	3.6%	.4%	0
Mississippi	694	*	73.2%	26.7%	*	*	337	0	68.5%	30.9%	0	.6%
Montana	346	0	91.0%	0	.3%	0	87	0	95.4%	.0%	0	1.1%
Nevada	480	3.3%	90.8%	2.9%	2.1%	.8%	102	4.9%	92.2%	2.9%	0	0
New Jersey	4,596	1.5%	90.3%	7.3%	1.0%	.04%	853	.8%	92.7%	5.7%	.7%	0
North Carolina	2,656	*	85.9%	13.1%	.2%	.8%	1,036	*	83.4%	15.8%	.2%	.6%
North Dakota	287	0	99.7%	0	0	.3%	66	0	100.0%			0
Ohio	3,802	.1%	97.0%	2.6%	.3%		1,226	.2%	94.7%	5.0%	.2%	0
Oklahoma	1,487	.1%	95.0%	2.9%	.1%	1.9%	576	.2%	95.5%	2.3%	.2%	1.9%
Pennsylvania	5,393	.1%	96.9%	2.9%	.1%	.02%	1,552	.2%	97.0%	2.5%	.1%	0
South Carolina	1,687	0	77.0%	22.8%	.2%	.1%	452	0	74.8%	25.2%	0	0
Texas	7398	5.2%	85.4%	8.6%	.5%	.3%	--	--	--	--	--	--
Utah	677	.1%	98.1%	.3%	.9%	.6%	311	0	98.1%	.0%	.96%	.96%
Virginia	2,602	.3%	86.7%	12.4%	.4%	.2%	779	0	85.4%	13.5%	.9%	.3%
Wisconsin	2,834	4	2,797	27	5	1	848	2	834	8	2	2
Total	49,080	859	43,579	3,246	884	144	12,242	134	10,944	904	189	45

*State does not collect or cannot report data for category

**Grades 7-12

Source: State Departments of Education, Data on Public Schools, Fall 1988

Table 7-2
RACE/ETHNICITY OF TEACHERS ASSIGNED
50% OR MORE IN CHEMISTRY & PHYSICS (Grades 9-12)

	CHEMISTRY						PHYSICS					
STATE	50% or More	Hispanic	White	Black	Asian	Indian	50% or More	Hispanic	White	Black	Asian	Indian
Alabama	125	0	84.8%	14.4%	0	.8%	51	0	86.3%	13.7%	0	0
Arkansas	75	0	93.3%	6.7%	0	0	6	0	100.0%	0	0	0
California	685	2.3%	88.8%	2.6%	4.2%	.7%	226	.4%	93.8%	.9%	4.4%	.4%
Connecticut	234	1.3%	97.4%	1.3%	0	0	128	0	99.2%	0	.8%	0
Delaware	24	0	95.8%	4.2%	0	0	39	0	94.9%	5.1%	0	0
Hawaii**	35	0	34.3%	0	62.9%	0	13	0	15.4%	0	84.6%	0
Idaho	53	0	100.0%	0	0	0	23	4.3%	95.7%	0	0	0
Kentucky	151	0	98.7%	.7%	.7%	0	15	0	100.0%	0	0	0
Mississippi	93	*	68.8%	31.2%	*	*	11	*	72.7%	27.3%	*	0
Montana	52	0	58.0%	.0%	0	0	17	0	94.0%	0	0	0
Nevada	34	0	97.1%	.0%	2.9%	0	15	0	93.3%	0	6.7%	0
New Jersey	137	.7%	96.6%	2.9%	1.5%	0	137	.7%	96.6%	2.9%	.7%	0
North Carolina	469	*	88.9%	9.6%	.4%	1.3%	264	*	94.3%	4.5%	.4%	.8%
North Dakota	21	0	100.0%	0	0	0	6	0	100.0%	0	0	0
Ohio	632	0	97.5%	2.1%	.5%	0	203	0	99.5%	.5%	0	0
Oklahoma	135	0	97.8%	1.5%	0	.7%	25	4.0%	96.0%	0	0	0
Pennsylvania	829	.1%	99.0%	.8%	*	*	457	0	99.3%	.4%	.2%	0
South Carolina	198	.5%	83.8%	14.6%	.5%	.5%	41	0	87.8%	9.8%	2.4%	0
Texas	783	4.1%	83.0%	8.3%	.6%	.1%	180	3.9%	89.4%	6.7%	0	0
Utah	69	0	98.6%	0	1.4%	0	21	4.8%	95.2%	0	0	0
Virginia	395	.3%	90.1%	8.1%	1.5%	0	156	1.3%	91.7%	6.4%	.6%	0
Wisconsin	309	0	98.4%	.6%	1.0%	0	118	0	99.2%	.8%	0	0
Total	5,538	55	5,058	274	76	15	2,152	14	2,046	60	28	3

*State does not collect or cannot report data for category

**Grades 7-12

Source: State Departments of Education, Data on Public Schools, Fall 1988

Table 8-1
MATHEMATICS TEACHERS (GRADES 9-12) BY PERCENT OF TEACHING ASSIGNMENT AND CERTIFICATION STATUS

STATE	TOTAL	ASSIGNED MATH 50% OR MORE		ASSIGNED MATH LESS THAN 50%	
		CERTIFIED MATHEMATICS	OUT OF FIELD	CERTIFIED MATHEMATICS	OUT OF FIELD
Alabama	1,609	74%	2%	20%	4%
California	9,603	52	15	16	16
Colorado	1,385	66	24	2	8
Connecticut	1,624	95	0	5	0
Idaho	607	87	0	7	6
Kentucky	1,691	79	3	9	10
Minnesota	1,860	71	1	26	2
Mississippi	763	85	6	6	3
Missouri	2,038	85	0	14	1
Montana	528	60	5	19	15
Nevada	642	66	9	18	7
New York	8,211	70	6	23	2
North Carolina	2,966	87	3	8	2
North Dakota	472	61	0	39	0
Ohio	4,197	89	1	9	0
Oklahoma	1,683	83	5	8	3
Oregon	1,325	80	0	8	12
Pennsylvania**	5,549	92	7	2	1
South Carolina	1,895	84	5	7	4
South Dakota	458	53	13	18	16
Utah	946	69	3	26	2
Virginia	3,133	82	1	15	2
Wyoming	363	72	0	28	0
Median		79%	3%	14%	3%

**Grades 7-12

Note: Alabama 50% or more, 2 teachers certified general secondary; less than 50%, 9 teachers
California 50% or more, 1,142 teachers certified general secondary; less than 50% 675 teachers

Source: State Departments of Education, Data on Public Schools, Fall 1988

Table 8-2
BIOLOGY TEACHERS (GRADES 9-12) BY PERCENT OF TEACHING ASSIGNMENT AND CERTIFICATION STATUS

STATE	TOTAL	ASSIGNED BIOLOGY 50% OR MORE			ASSIGNED BIOLOGY LESS THAN 50%		
		Certified Biology	Certified Broad Field	Out of Field	Certified Biology	Certified Broad Field	Out of Field
Alabama	800	48%	12%	2%	28%	10%	1%
California	3,628	*	44	15	*	28	13
Connecticut	566	85	*	0	14	*	0
Idaho	200	92	*	0	7	*	2
Kentucky	709	38	1	0	57	2	2
Minnesota	752	46	14	1	28	9	2
Mississippi	418	72	*	8	14	*	3
Missouri	1,003	65	*	1	31	*	2
Montana	212	25	*	16	36	*	23
Nevada	193	16	35	3	7	37	3
New York	5,224	59	*	5	33	*	3
North Carolina	1,181	47	39	1	6	5	1
North Dakota	258	22	4	0	53	21	0
Ohio	1,685	15	57	1	10	17	0
Oklahoma	912	61	*	2	34	*	3
Oregon	316	83	*	1	11	*	6
Pennsylvania**	1,737	81	5	3	10	1	0
South Carolina	632	40	30	1	9	16	4
South Dakota	232	22	11	5	31	11	20
Utah	438	85	*	6	28	*	1
Virginia	1,001	77	*	1	20	*	2
Wyoming	142	51	*	0	49	*	0
Median		51%	12%	1%	28%	11%	2%

*State does not have certification in category

**Grades 7-12

Note: California 50% or more , 353 teachers certified general secondary; less than 50% , 218 teachers

Alabama less than 50%, 1 teacher certified general secondary

Source: State Departments of Education, Data on Public Schools, Fall 1988

Certified in Field/Subject: Regular or Standard certification offered in a state or Probational certification (i.e., the initial certification issued after satisfying all requirements except the completion of probationary period)

Specific Field: State certification in specific science field of assignment

Broad-Field: Broad-field science certification

General Secondary: Teachers with only a general secondary certification, i.e., certification to teach any subject at secondary level

Out-of-Field: Regular/standard/ probationary certification in a field/subject other than the one assigned, or temporary, provisional, or emergency certification

Table 8-3
CHEMISTRY TEACHERS (GRADES 9-12) BY PERCENT OF TEACHING ASSIGNMENT AND CERTIFICATION STATUS

STATE	TOTAL	ASSIGNED CHEMISTRY 50% OR MORE			ASSIGNED CHEMISTRY LESS THAN 50%		
		Certified Chemistry	Certified Broad Field	Out of Field	Certified Chemistry	Certified Broad Field	Out of Field
Alabama	360	21%	14%	0%	27%	33%	6%
California	1,314	*	39	13	*	34	14
Connecticut	293	80	*	0	20	*	0
Idaho	54	98	*	0	2	*	0
Kentucky	347	40	4	0	45	6	5
Minnesota	487	23	15	2	33	20	7
Mississippi	144	49	*	16	19	*	17
Missouri	566	39	*	1	57	*	4
Montana	137	19	*	3	31	*	47
Nevada	61	25	30	2	5	39	0
New York	1,925	60	*	6	32	*	3
North Carolina	553	22	63	0	3	12	0
North Dakota	147	8	6	0	27	59	0
Ohio	985	28	35	1	19	16	0
Oklahoma	469	28	*	1	65	*	7
Pennsylvania	982	66	15	4	10	5	1
South Carolina	322	13	47	2	4	28	6
South Dakota	148	8	10	3	14	21	44
Utah	102	63	*	5	30	*	2
Virginia	543	71	*	2	22	*	5
Wyoming	99	29	*	0	71	*	0
Median		29%	15%	2%	22%	20%	3%

*State does not have certification in category

Note: California 50% or more, 124 teachers certified general secondary; less than 50%, 66 teachers

Source: State Departments of Education, Data on Public Schools, Fall 1988

Table 8-4
PHYSICS TEACHERS (GRADES 9-12) BY PERCENT OF TEACHING ASSIGNMENT AND CERTIFICATION STATUS

STATE	TOTAL	ASSIGNED PHYSICS 50% OR MORE			ASSIGNED PHYSICS LESS THAN 50%		
		Certified Physics	Certified Broad Field	Out of Field	Certified Physics	Certified Broad Field	Out of Field
Alabama	324	3%	9%	4%	10%	52%	23%
California	845	*	20	6	*	56	17
Connecticut	181	70	*	0	29	*	0
Idaho	27	85	*	0	7	*	7
Kentucky	210	4	2	1	61	14	17
Minnesota	378	16	8	1	36	28	12
Mississippi	46	13	*	11	28	*	50
Missouri	374	15	*	1	70	*	15
Montana	117	8	*	7	16	*	69
Nevada	45	13	18	2	16	47	0
New York	1,189	34	*	8	46	*	12
North Carolina	331	10	66	4	2	18	1
North Dakota	143	1	3	0	18	78	0
Ohio	742	13	14	1	40	32	1
Oklahoma	222	9	*	3	66	*	23
Pennsylvania	641	53	13	5	14	12	2
South Carolina	214	4	14	1	7	64	10
South Dakota	130	2	4	2	10	32	51
Utah	63	32	*	2	67	*	0
Virginia	332	44	*	3	40	*	13
Wyoming	78	10	*	0	90	*	0
Median		13%	13%	2%	28%	32%	12%

*State does not have certification in category

Note: California 50% or more, 45 teachers certified general secondary; 50% or less, 94 teachers

Source: State Departments of Education, Data on Public Schools, Fall 1988

Table 8-5
STATE CERTIFICATION REQUIREMENTS FOR SECONDARY SCIENCE AND MATHEMATICS TEACHERS

	Course Credits by Certification Field			Teaching Methods Required:	Superv. Teaching Experience
STATE	MATH	SCIENCE, BROAD FIELD	BIOLOGY CHEMISTRY PHYSICS	Science/ Math	Required
Alabama	27	52	27	Yes	9
Alaska	•	•	•	•	•
Arizona	30	30	30	Yes	8
Arkansas	21		24	No	12 wks
California	45	45 (Biological, Physical)		No	•••
Colorado	•	•	•	Yes	400 hrs
Connecticut	18		18	No	6
Delaware	30		39-45	Yes	6
Dist. of Columbia	27	30	30	Yes	1 sem.
Florida	21		20	Yes(S)	6
Georgia	60 qtr	45qtr	40 qtr	Yes(M)	15 qtr hrs
Hawaii	•	•	•	•	•
Idaho	20	45	20	No	6
Illinois	24	32	24	Yes	5
Indiana	36	36	36	Yes	9 wks
Iowa	24	24	24	Yes	Yes
Kansas	•	•	•	•	•
Kentucky	30	48	30	No	9-12
Louisiana	20		20	No	9
Maine	18	18		Yes	6
Maryland	24	36	24	Yes	6
Massachusetts	36	36	36	Yes	300 hrs
Michigan	36	30	30	No	6
Minnesota	••	••	••	••	••
Mississippi	24		32	Yes(S)	6
Missouri	30	30	20	Yes	8
Montana	30	60	30	Yes	10 wks
Nebraska	30	45	24	Yes	320 hrs
Nevada	16	36	16	No	8
New Hampshire	•	•	•	•	•
New Jersey	30	30	30	No	•
New Mexico	24	24	24	Yes	6
New York	24		36	No	•
North Carolina	••	••	••	••	••
North Dakota	16	21	12	No	6
Ohio	30	60	30	Yes	•••
Oklahoma	40		40	No	12 wks
Oregon	21	45	45	Yes(M)	15 qtr hrs
Pennsylvania	•	•	•	•	•
Rhode Island	30	30	30	Yes	6
South Carolina	•	•	•	•	•
South Dakota	18	21	12	No	6
Tennessee	36 qtr	48 qtr	24 qtr	Yes	4
Texas	24	48	24	No	6
Utah	••	••	••	••	••
Vermont	18	18	18	Yes	•
Virginia	27		24	No	6
Washington	24	41	34	No	Yes
West Virginia	••	••	••	••	••
Wisconsin	34	54	34	Yes	5
Wyoming	24	30	12	No	1 course

Notes:

Blank space = No certification offered

Course credits = Semester credit hours, unless otherwise specified (e.g., qtr = quarter credit hours)

• Certification requirements determined by degree-granting institution or approved/competency-based program

••Major or minor - North Dakota, Utah; 20-40% of program - Minnesota, North Carolina. Courses matched with requirements - West Virginia

•••1 semester full-time or 2 semesters half-time–California, supervised teaching experience and 300 hours clinical/field based experience–Ohio

Source: State Departments of Education, June 1987

A Quote by President Dwight D. Eisenhower to the National Education Association: October 1, 1956.

"Our American educational system can never be any better than the men and women who instruct our children. We have better teachers than ever before, but we need more of them than ever before. And if we are to continue to have the finest teaching staff in the world, our teachers must be compensated adequately--in salary, in community support and in honor for the sacred trust they bear: the education of future Americans"